HARD X-RAY EMISSION OF X-RAY BURSTERS

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Final Report

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The primary goal of this proposal was to perform an accurate measurement of the broad-band x-ray spectrum of a neutron-star low-mass x-ray binary found in a hard x-ray state. This goal was accomplished using data obtained under another proposal (NASA NAG5-7334, RXTE: Simultaneous Spectral and Timing Observations of Accreting Neutron Stars, PI: Philip Kaaret), which has provided exciting new information on the hard x-ray emission of neutron-star low-mass x-ray binaries. In "BeppoSAX Observations of the Atoll X-Ray Binary 4U0614+091", by S. Piraino, A. Santangelo, E.C. Ford, and P. Kaaret, published in Astronomy and Astrophysics Letters, we present our analysis of the spectrum of 4U0614+091 over the energy band from 0.3-150 keV. Our data confirm the presence of a hard x-ray tail that can be modeled as thermal Comptonization of low-energy photons on electrons having a very high temperature, greater than 220 keV, or as a non-thermal powerlaw. Such a very hard x-ray spectrum has not been previously seen from neutron-star low-mass x-ray binaries. We also detected a spectral feature that can be interpreted as reprocessing, via Compton reflection, of the direct emission by an optically-thick disk and found a correlation between the photon index of the power-law tail and the fraction of radiation reflected which is similar to the correlation found for black hole candidate x-ray binaries and Seyfert galaxies.

A secondary goal was to measure the timing properties of the x-ray emission from neutron-star low-mass x-ray binaries in their low/hard states. This was accomplished using observations obtained under this proposal during a hard x-ray outburst of the source 4U1705-44. In "Measurement of Hard Lags and Coherences in the X-Ray Flux of Accreting Neutron Stars and Comparison with Accreting Black Holes", by E.C. Ford, M. van der Klis, M. Mendez, J. van Paradijs, and P. Kaaret, published in the Astrophysical Journal Letters, we present our analysis of soft x-ray versus hard x-ray timing lags from 4U1705-44 along with measurements of timing lags in another neutron star system and two black hole systems. We find similar timing lags in both the neutron star and black hole systems. This unexpected result places strong constraints on the physical origin of these timing lags and rules out the model most widely considered, that of Comptonization in a uniform medium.

In addition, data obtained under this proposal was used for a study of the correlations between x-ray timing properties and x-ray spectral state in the paper, "Relations Between Timing Features and Colors in the X-Ray Binary 4U0614+09", by S. van Straaten, E.C. Ford, M. van der Klis, M. Mendez, and P. Kaaret. This paper has been accepted by the Astrophysical Journal, but a publication date has not yet been set.

Papers -

"BeppoSAX Observations of the Atoll X-Ray Binary 4U0614+091", S. Piraino, A. Santangelo, E.C. Ford, and P. Kaaret, Astronomy and Astrophys. Letters, 49, L77-L81 (1999).

"Measurement of Hard Lags and Coherences in the X-Ray Flux of Accreting Neutron Stars and Comparison with Accreting Black Holes", E.C. Ford, M. van der Klis, M. Mendez, J. van Paradijs, and P. Kaaret, Astrophys. J. Letters 512, L31 (1999).

"Relations Between Timing Features and Colors in the X-Ray Binary 4U0614+09", S. van Straaten, E.C. Ford, M. van der Klis, M. Mendez, and P. Kaaret, has been accepted by the Astrophysical Journal.